Remarks

With the cancellation of Figs. 2b and 2c, the drawings in this case are Figs. 1, 2a, 3-13.

With the cancellation of claims 5 and 26, and the addition of new claim's 40-78, the claims in the case are now 4, 6-7, 25, 27-29 and 40-78.

A check for the additional claims is enclosed.

Claims 4, 6-7, and 25, 27-29 stand rejected as obvious (§103) over Bramm et al. in view of Waldron (claims 4, 6-7) and obvious (§103) over Isaacson in view of Waldron (claims 25, 27-29). Also, the Examiner has objected to the specification under §112 as failing to provide an enabling disclosure with regard to a current carrying solenoid fixed to an impeller means that is free floating.

1. §103 Obviousness Rejection - Claims 4, 6-7

It will be shown below that claims 4, 6-7 are not obvious under 35 U.S.C. §103 over Bramm (4,944,748) in view of Waldron (3,597,022) because (1) there is no disclosure in either Bramm or Waldron of magnet means which includes permanent magnets, solenoids, and electromagnets fixed with respect to the housing in conjunction with diamagnets fixed with respect to the impeller to provide both axial and radial stabilization of the impeller; and (2) there is no suggestion for combining Bramm and Waldron.

A. Neither Bramm nor Waldron Teach the Use of Magnet Means and Diamagnets For Both Axial and Radial Stabilization

Claim 4 and its dependent claims 6-7 have been amended to require that the plurality of magnet means in the housing be "oriented generally axially and

radially with the plurality of diamagnets in the impeller, to thereby stabilize the impeller in both the axial and radial directions by magnetic forces levitating said impeller." Support for this amendment is found on page 15, lines 3-13 of the specification. This limitation or feature of distinct axial and radial magnetic forces for impeller stability is believed to be the basis for allowance in U.S. Patent No. 5,195,877, the parent to the present application.

The reason for having axial and radial stability provided by the use of diamagnets in the impeller and magnet means in the housing is that if permanent magnets were used to stabilize in one direction, a very large diamagnet would be required to prevent Earnshaw's forces (i.e, Earnshaw's theorem states that in a non-dynamic system composed solely of permanent magnets, it is impossible for a body to be supported in stable equilibrium against displacement in all directions) from causing displacement in the other direction. Consequently, to be able to use small diamagnets with small permanent magnets to stabilize the structure so that the weight of the diamagnet is not greatly increased, a combination of permanent magnets should not be used to stabilize the structure in one direction.

Neither Bramm nor Waldron, individually or in combination, disclose the use of diamagnets with magnet means for both axial and radial stabilization wherein the magnet means and diamagnets are oriented generally both axially and radially. Consequently, Bramm and Waldron cannot be combined to teach the present invention as claimed.

In Bramm, permanent magnets stabilize the impeller in the radial direction. An electromagnet in conjunction with a permanent magnet in the impeller stabilize the impeller in the axial direction. In Bramm, the outside ends of the permanent magnets in the impeller are in axial alignment with the inside faces of the permanent magnets in the housing. The electromagnet in the housing is also positioned coaxially with the permanent magnets in the impeller. However, the permanent magnets in the impeller are not oriented radially with the electromagnets or the permanent magnets in the housing. Also, Bramm does not teach diamagnets with magnet means to stabilize the impeller in the axial and radial directions.

Waldron discloses two configurations for stabilizing a structure using permanent magnets and diamagnets: (1) placing the diamagnet in axial communication with the permanent magnet and having the permanent magnet in radial communication with another permanent magnet; and (2) placing the diamagnet in vectorial communication (see Fig. 1) with a magnetic field caused by the attraction of the south pole and north pole of a permanent magnet. Neither configuration can be combined with Bramm to teach or suggest the present invention.

First, if either configuration disclosed in Waldron were combined with the device in Bramm, the present invention would not result. The requirement in claim 4 and its dependent claims 6-7 that the magnet means be oriented generally axially and radially with the diamagnets would not be met because none of the

magnets in Bramm are in radial communication with the magnets in the impeller. Consequently, the diamagnets cannot be placed in radial communication with permanent magnets in either the housing or the impeller.

Moreover, even if a diamagnet were placed in the housing in place of the electromagnet such that the permanent magnets in the impeller and the housing provide stability in the radial direction, this structure would not suggest the present invention. In Bramm, the permanent magnets provide large permanent magnetic forces on the impeller to support the impeller within the impeller chamber (col. 8, lines 44-46). The diamagnet in the housing and permanent magnet in the impeller must provide sufficient magnetic force to be able to stabilize the impeller in the axial direction. However, Waldron does not discuss Earnshaw's theorem. In fact, Waldron does not disclose or solve the problem of overcoming the repulsive forces caused by the permanent magnets which stabilize in the radial direction and still have adequate repulsive forces to provide an axially stable levitated body. Therefore, combining Bramm and Waldron does not make claims 4 and its dependent claims 6-7 obvious.

By having diamagnets and magnet means generally in axial and radial communication with each other such that the permanent magnets are generally oriented in both the axial and radial directions with the diamagnets, this problem of overcoming large permanent magnet forces is avoided.

Second, placing the diamagnets in the impeller of the device in Bramm does not disclose the present invention as claimed. The present invention

as claimed requires both axial and radial orientation as between the diamagnet and the permanent magnet. If the diamagnet were in the impeller, the diamagnet would not be in radial communication with the permanent magnet and electromagnet in the housing. The diamagnet in the impeller would also be axially oriented with respect to the electromagnet in the housing. Therefore, Bramm in view of Waldron does not suggest the present invention.

The problem of the strength of the magnetic field is not present when the magnet means in the housing are oriented generally both axially and radially with the diamagnets in the impeller. The configuration of the magnets in the present invention as claimed provides both magnetic levitation of the impeller and axial and radial stability of the impeller.

Therefore, claim 4 and its dependent claims 6-7 are not obvious over Bramm in view of Waldron.

B. Waldron Cannot be Combined With Bramm Because There is No Suggestion For Combination

To combine two references, there must be some suggestion, implied or explicit, for combining the two references. In this case, Waldron does not suggest combination with Bramm. Waldron does not disclose pumps as a possible application. In Waldron, all the devices disclosed react to work done on it, i.e., kinematic sensing, force sensing, and linkage devices. Whereas, the present invention is a work producing device.

Also, when Waldron states that "[t]his leads to substantially improved load capacity for a given magnet configuration or conversely to greatly reduced

weight and volume of magnet assembly for a given load", Waldron is referring to replacing single crystal graphite, a diamagnet, with pyrolytic graphite, another diamagnet. Waldron is not suggesting replacing a permanent magnet with a diamagnet.

Therefore, claim 4 and its dependent claims 6-7 are not made obvious by Bramm in view of Waldron.

2. §103 Rejections - Claims 25, 27-29

Claim 25 and its dependent claims 27-29 are not obvious under 35 U.S.C. §103 over Isaacson (5,112,200) in view of Waldron because (1) there is no disclosure of magnetic levitation in Isaacson; and (2) there is no suggestion of combining Isaacson and Waldron.

A. Because Isaacson Does Not Disclose Magnetic Levitation, Isaacson Combined With Waldron Does Not Teach The Present Invention.

As amended, claim 25 calls for a plurality of magnet means fixed with respect to said central frame, in magnetic communication with said plurality of diamagnets, and oriented generally axially and radially with said plurality of diamagnets, to thereby stabilize said impeller in both the axial and radial directions by magnetic forces levitating said impeller.

Isaacson does not use magnets in both the axial and radial directions to produce levitation. Although he uses permanent magnets to repel the retrothrust created by the rotor when pumping, the permanent magnets which are spread around the perimeter of the rotor are not opposed by a permanent magnet or magnets, and are used only for purposes of interacting with the flux created by the

stator to produce rotation of the rotor. Thus, Isaacson cannot be combined with Waldron because there is no place in Isaacson for placing a diamagnet to repel a permanent magnet for levitation of the stator. Moreover, Isaacson does not levitate his stator via magnets. He achieves levitation through a leakage flow of blood in the gap between the cylindrical surfaces. Consequently, claims 25 and its dependent claims 27-29 are not obvious over Isaacson in view of Waldron.

B. Waldron Cannot be Combined With Isaacson Because There is No Suggestion For Combination

To combine two references, there must be some suggestion, implied or explicit, for combining the two references. In this case, Waldron does not suggest combination with Isaacson. Waldron does not disclose pumps as a possible application. In Waldron, all the devices disclosed react to work done on it, i.e., kinematic sensing, force sensing, and linkage devices, whereas, the present invention is a work producing device. Therefore, the present invention as claimed is not obvious over Isaacson in view of Waldron.

Also, when Waldron states that "[t]his leads to substantially improved load capacity for a given magnet configuration or conversely to greatly reduced weight and volume of magnet assembly for a given load", Waldron is referring to replacing single crystal graphite, a diamagnet, with pyrolytic graphite, another diamagnet. Waldron is not suggesting replacing a permanent magnet with a diamagnet.

Therefore, claims 25 and its dependent claims 27-29 are not made obvious by Isaacson in view of Waldron.

3. § 112 Objection

The Examiner objected to the specification under 35 U.S.C. § 112, first paragraph, as failing to provide an enabling disclosure with regard to the disclosure of a current carrying solenoid fixed to an impeller means that is free floating. Applicant has deleted Figs. 2b and 2c and the corresponding description on page 9, lines 3-9, and page 17, lines 4-13. Consequently, the basis for the objection under section 112 as failing to provide an enabling disclosure is removed. However, applicant reserves the right to include the deleted embodiments in a continuation-in-part application.

4. Claims 40-63

Claims 40-63 cover several combinations of permanent magnets and diamagnets in the impeller and the housing or central frame. These claims are supported in the specification on page 15, lines 19-21 and page 16 lines 1-2. Also, dependent claims 42, 45, 48, 51, 54, 57, 60 and 62 are supported in the specification from page 18 line 3 to page 24, line 14. All of these claims are limited to combinations of permanent magnets and diamagnets. First, claims 40-51 claim embodiments of the fluid pump claimed in claim 4. These claims cover embodiments of the present invention in which (i) the permanent magnets are in the impeller and the diamagnets are in the housing (claims 40 and 43); (ii) the diamagnets are axially fixed with respect to the impeller and radially fixed with

respect to the housing and the permanent magnets are axially fixed with respect to the housing and radially fixed with respect to the impeller (claims 40 and 46); and (iii) the diamagnets are radially fixed with respect to the impeller and axially fixed with respect to the housing and the permanent magnets are radially fixed with respect to the housing and axially fixed with respect to the impeller (claims 40 and 49). As in claim 4, these claims require axial and radial orientation of the diamagnets with the permanent magnets to stabilize the impeller in both the axial and radial directions.

Similar to claim 7, dependent claims 41, 44, 47 and 50 claim that the impeller has a density substantially similar to the density of the fluid pumped by said fluid pump.

Dependent claims 42, 45, 48, and 51 claim levitation of the impeller by fluid forces in either the axial and/or radial direction in conjunction with the magnetic levitation.

Similarly, claims 52-63 claim embodiments of the fluid pump claimed in claim 25. These claims cover embodiments of the present invention in which (i) the permanent magnets are in the impeller and the diamagnets are in the central frame (claims 52 and 55); (ii) the diamagnets are axially fixed with respect to the impeller and radially fixed with respect to the central frame and the permanent magnets are axially fixed with respect to the central frame and radially fixed with respect to the impeller (claims 52 and 58); and (iii) the diamagnets are radially fixed with respect to the impeller and axially fixed with respect to the central frame and

the permanent magnets are radially fixed with respect to the central frame and axially fixed with respect to the impeller (claims 52 and 61). As in claim 25, these claims require axial and radial orientation of the diamagnets with the permanent magnets to stabilize the impeller in both the axial and radial directions.

Dependent claims 53, 56, 59, and 62 claim that the impeller has a density substantially similar to the density of the fluid pumped by said fluid pump.

Dependent claims 54, 57, 60, and 63 claim levitation of the impeller by fluid forces in either the axial and/or radial direction in conjunction with the magnetic levitation.

5. Claims 61-78

Claims 64 to 78 are claims for the embodiment illustrated in Fig. 4 and variations of the embodiment shown. These claims cover embodiments of the present invention in which (i) the permanent magnets are fixed with respect to the housing, the central frame, or the impeller and are in communication with a diamagnet in the housing, the central frame, or the impeller such that the plurality of permanent magnets are oriented generally axially and radially with the plurality of diamagnets (claim 64); (ii) the diamagnets are fixed with respect to the impeller and the magnet means are radially fixed with respect to the central frame and axially fixed with respect to the housing (claim 67); the diamagnets are fixed with respect to the impeller and the magnet means are radially fixed with respect to the housing and axially fixed with respect to the central frame (claim 70); the permanent magnets are fixed with respect to the impeller and the diamagnets are radially fixed with

respect to the central frame and axially fixed with respect to the housing (claim 64 and claim 73); and the permanent magnets are fixed with respect to the impeller and the diamagnets are axially fixed with respect to the central frame and radially fixed with respect to the housing (claim 64 and claim 76).

Similar to claim 29, dependent claims 65, 68, 71, 74, and 77 claim that the impeller has a density substantially similar to the density of the fluid pumped by said fluid pump.

Dependent claims 66, 69, 72, 75, and 78 claim levitation of the impeller by fluid forces in either the axial and/or radial direction in conjunction with the magnetic levitation. Support for these claims are found in the specification from page 18, line 3 to page 24, line 14.

Applicant has complied with or obviated by amendment each of the bases for rejection of the claims on technical grounds and has clearly pointed out why the claims are not obvious over Bramm in view of Waldron or Isaacson in view of Waldron. The new claims added by applicant are variations disclosed in the specification of independent claims 4 and 25 which contain the axial and radial stabilization required in claims 4 and 25.

Because the number claims in the application as amended is greater than the original number of claims in the application as filed, a check has been enclosed to pay for the additional claims in the application. Also, a petition for a one-month extension of time (from August 2, 1994 to September 2, 1994) within which to respond to the Office Action is enclosed, along with a check in the amount of $354.00 to cover the fee associated with the petition and additional claims. Additionally, although a check for the increased number of claims and the petition fee are enclosed, the Office is hereby authorized to charge any deficiency or credit any overpayment associated with this communication to Deposit Account No. 04-1420.

Respectfully submitted,

Dated: 8/25/94

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